ProDAVis: Process Data Analysis and Visualization at Covestro

Dr. Esteban Arroyo, Dr. Philipp Frenzel

Speakers

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- Covestro
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Covestro

World-leading chemical manufacturer of high-tech materials

✓ 16.800 employees ✓ Total revenue of €14.6 bn ✓ 30 production sites worldwide

POLYURETHANES

€7.4bn | 51%

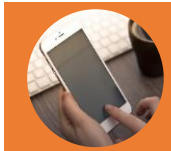

Your car seats


Your house


Your sofa

POLYCARBONATES

€4.1bn | 28%


Your smartphone

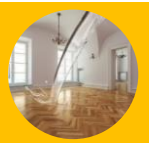

Performance cars

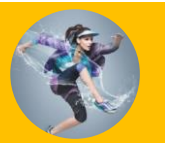

Medical products

COATINGS, ADHESIVES & SPECIALTIES

€2.4bn | 16%


Car coating


Robust floors


Your sports outfit

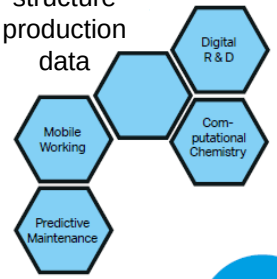
Digital@Covestro: 3 Dimensions

Digital Operations

Leverage data and break data silos to improve safety and increase efficiency

Collect and structure production data

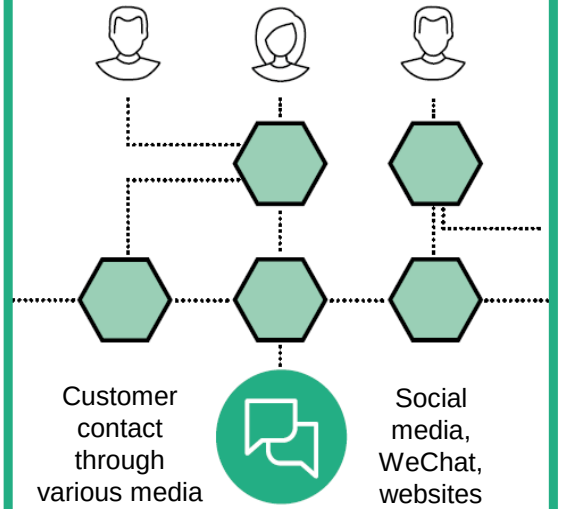
Visualize, analyze & predict



Global impact on production, R&D, commercial and strategic decision making

Customer experience

Support dynamic customer decisions across multiple digital touchpoints



Customer contact through various media

Social media, WeChat, websites

Business models

Use digital technologies to enhance customer benefits

ONLINE MARKETPLACE
Buy and sell chemicals

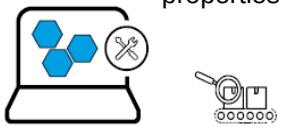
ALIBABA FLAGSHIP STORE
Sell to smaller customers as well

1

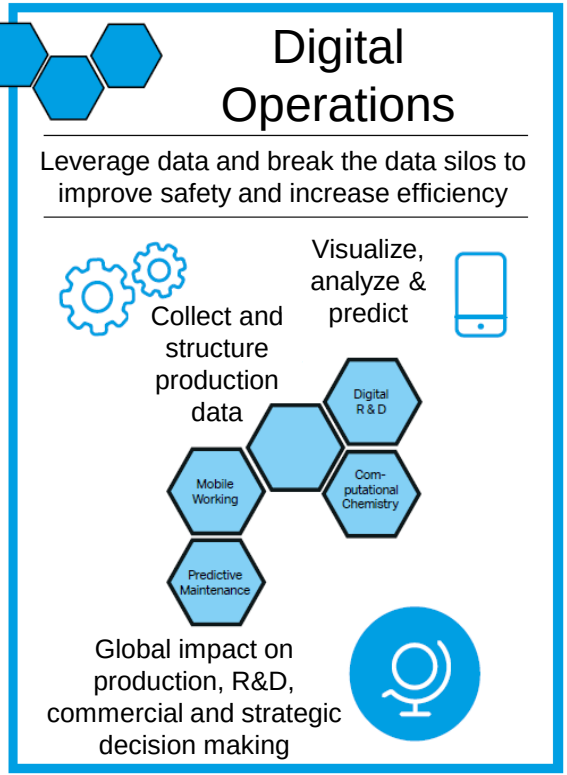
TECHNICAL CUSTOMER SERVICES

Predict product properties

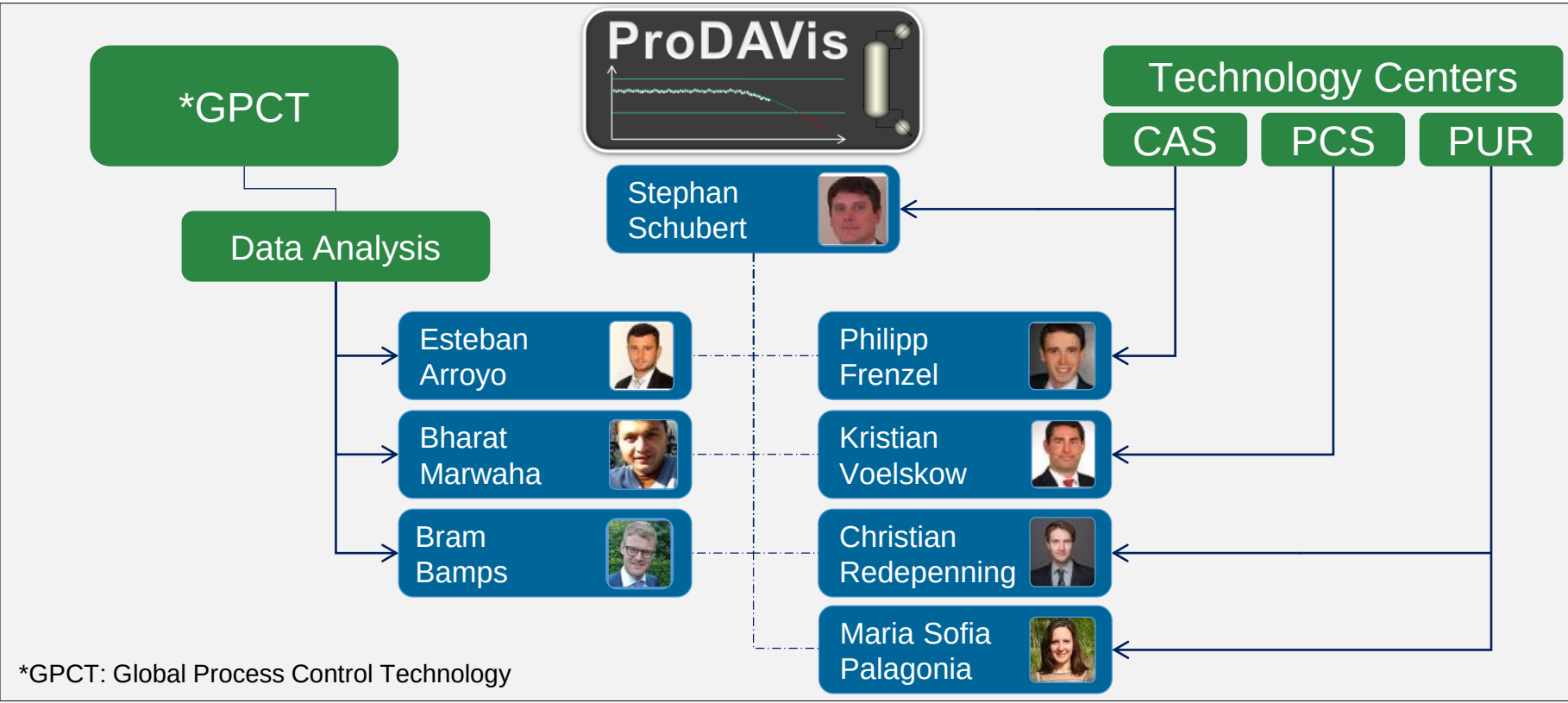
2



Digital Operations @ Covestro



ProDAVis: Process Data Analysis & Visualization



ProDAVis Target Setting

Goals

- **Enable efficient data analysis in production and technology centers**
- **Standardize the way we access and visualize data**
- **Capture, share and retain knowledge to face ongoing generation change**
- **Enhance collaboration between groups**

Data Analytics Architecture

PREDICT
Advanced forecasts, scenario testing

ANALYZE
Root cause analysis, pattern recognition

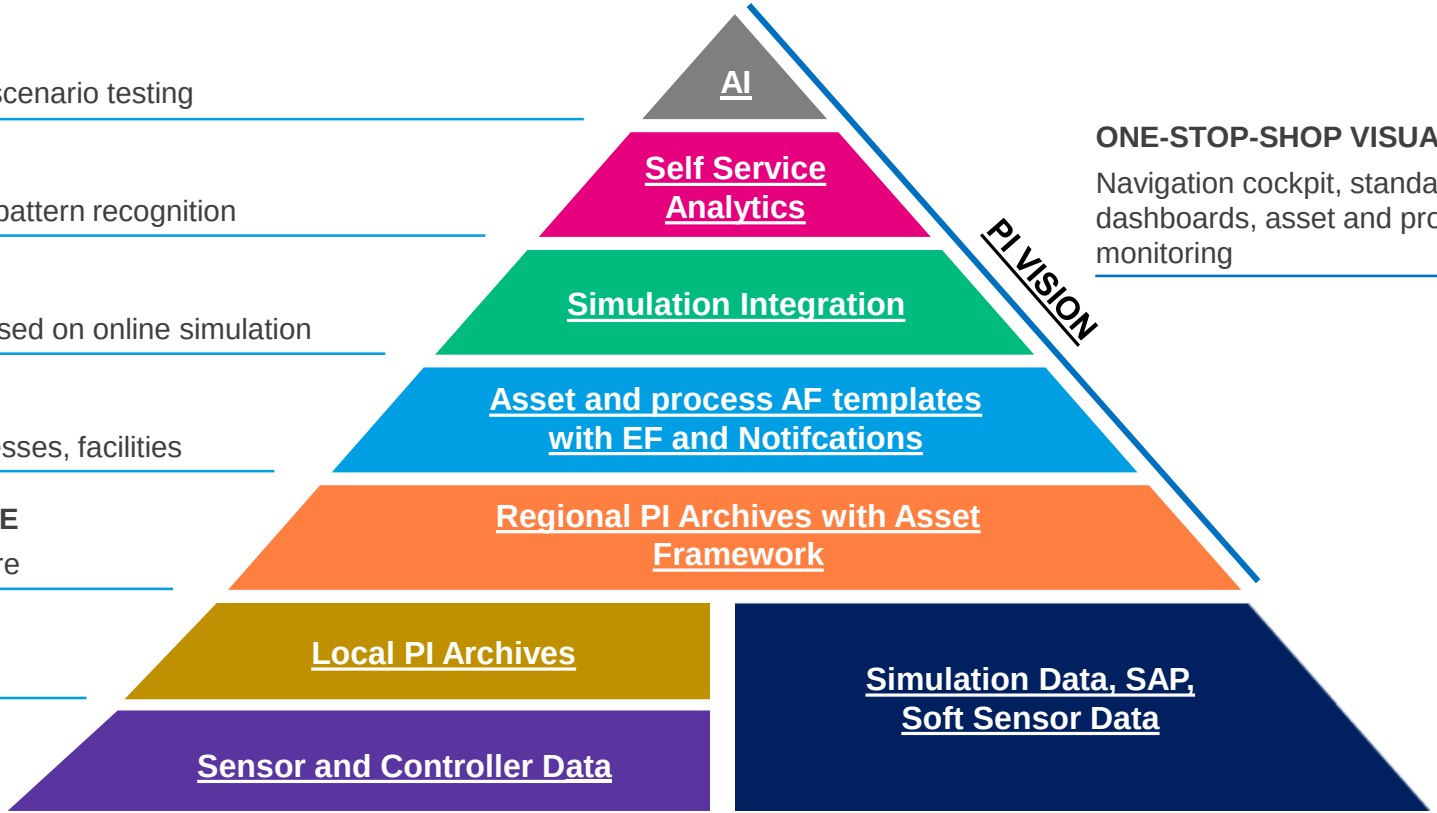
SIMULATE
Anomaly detection based on online simulation

MONITOR
Unit operations, processes, facilities

MOVE & STRUCTURE
Standard nomenclature

COLLECT
Operational data

MEASURE
Operational data



ONE-STOP-SHOP VISUALIZATION
Navigation cockpit, standard dashboards, asset and process monitoring

Data Analytics Architecture Implementation

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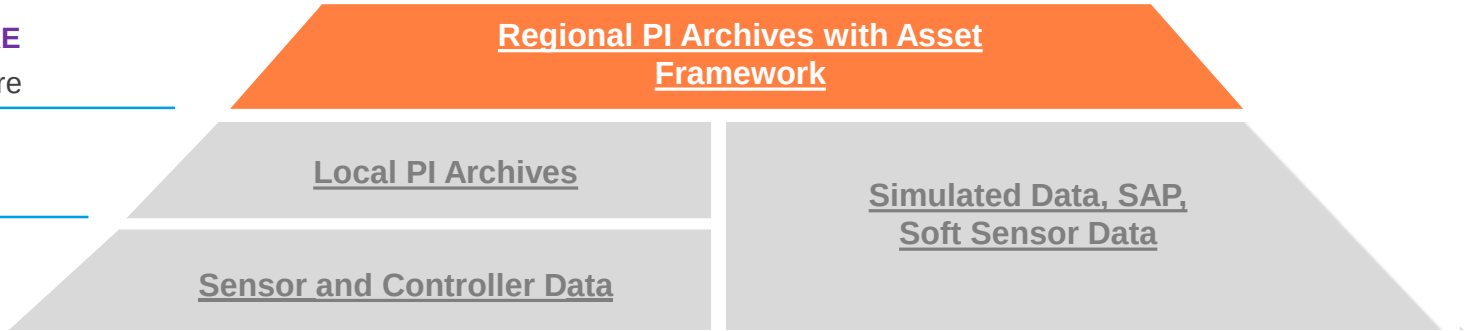
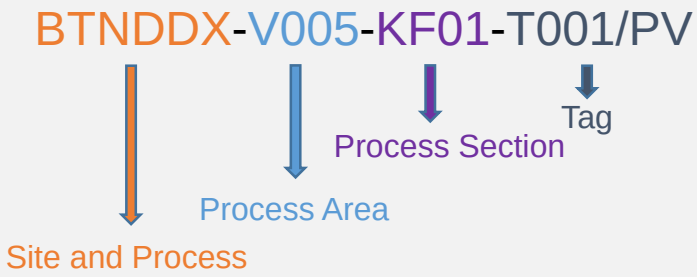
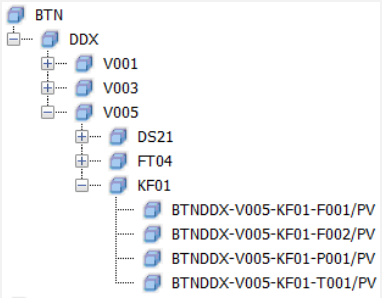


Move & Structure: FLoc Tag Hierarchy

- Tag standardization based on 4 level FLoc nomenclature:

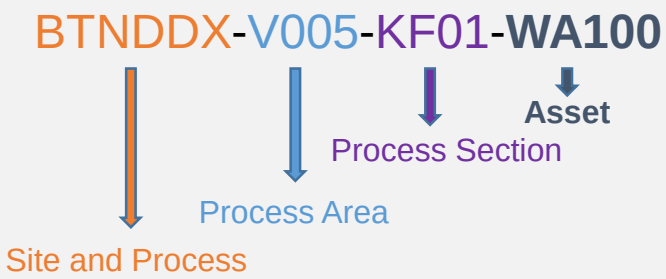


- Definition of a **tag hierarchy** based on FLoc nomenclature



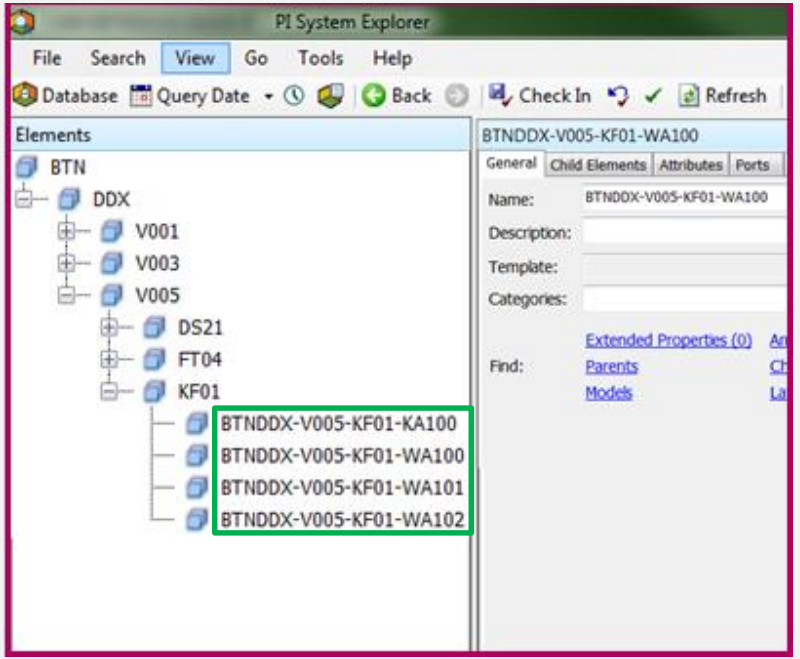
Move & Structure: FLoc Asset Hierarchy

- Definition of **asset hierarchy** based on FLoc



- Elements in this hierarchy are based on templates

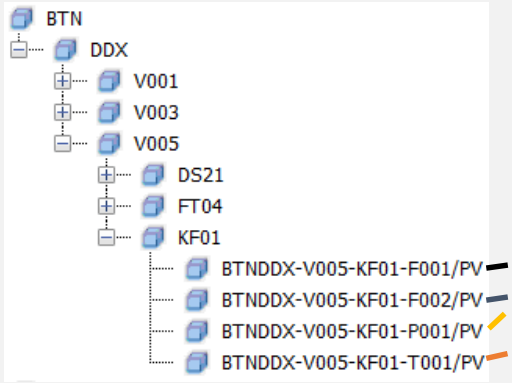
  → Examples of typical templates include Pumps, HEx, Distillation Columns, Reactors, etc.



Move & Structure: Internal References

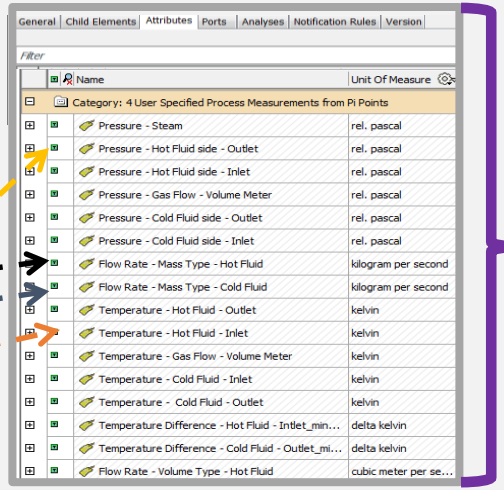
- Definition of **internal references** among tag and asset hierarchies

✓**Tag AF hierarchy**



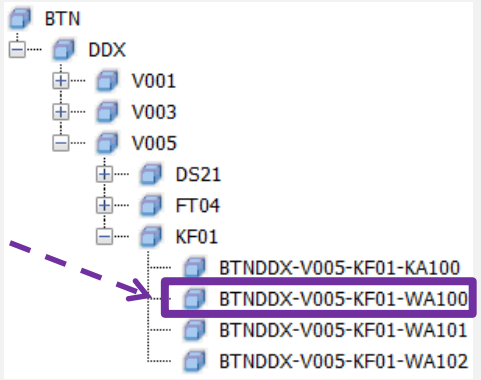
“Data Source“

✓**Template attributes**



Data + Context + Calculations

✓**Asset AF hierarchy**



“Data Consumer“

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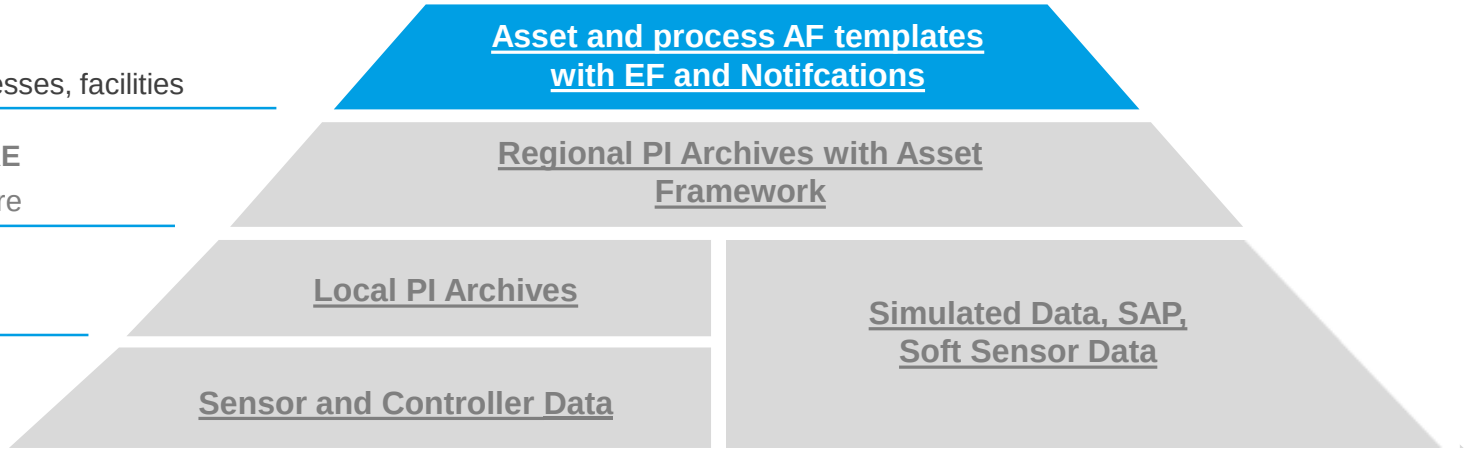
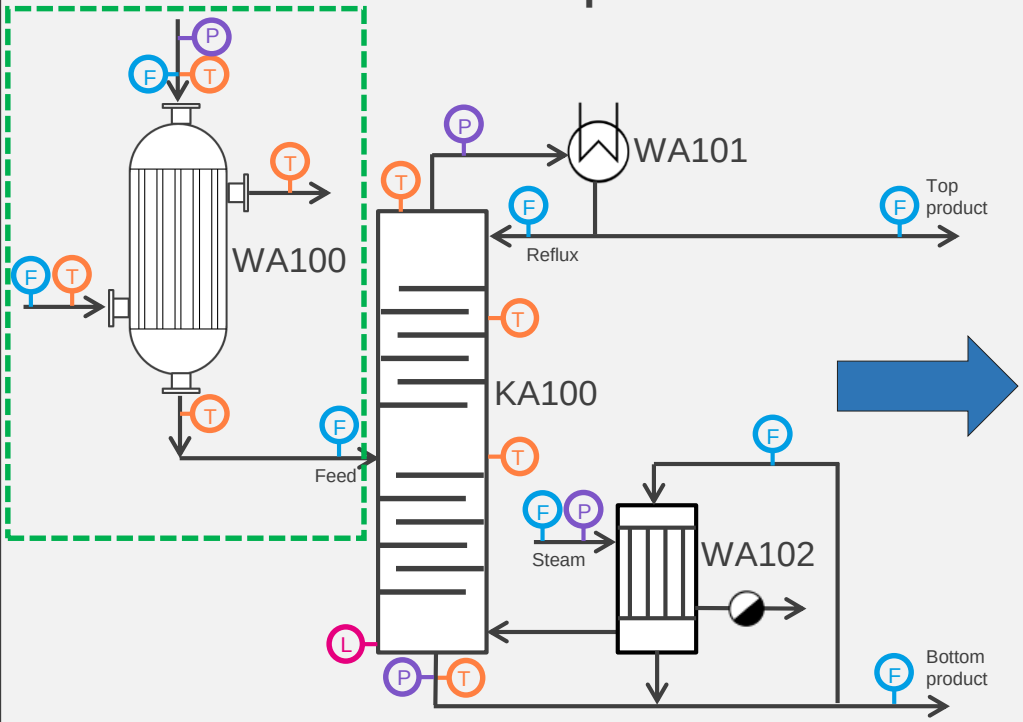
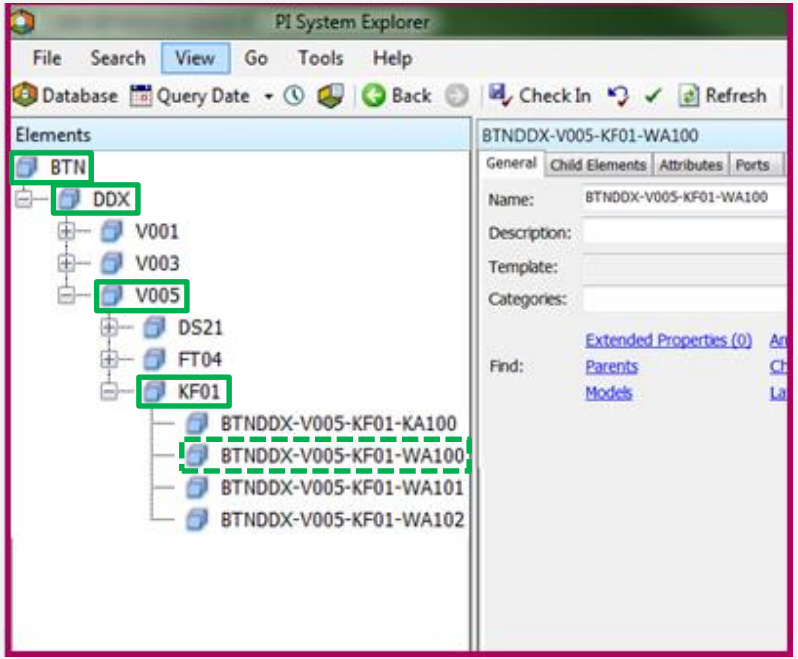


Monitor: AF Template Development

Process section KF01 of process area V005 in the DDX plant in Baytown (BTN)

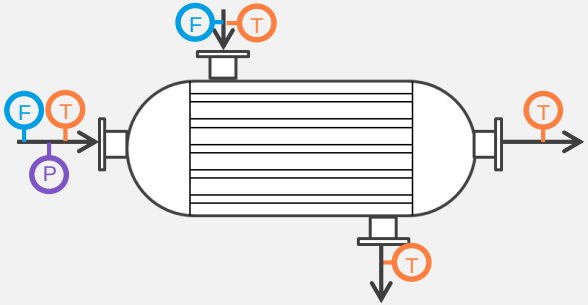




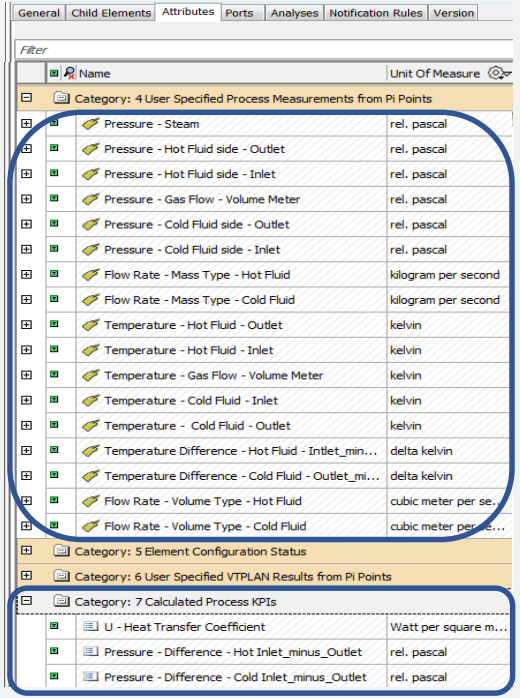
Monitor: AF Template Development

Measured process variables for WA100:

- **Flowrates**, **Temperatures**, **Pressures**



Standardized
PI AF Template



Calculated KPI's for WA100:

- Heat transfer coefficient "**U**"

$$U = f(\Delta T_{hot}, \Delta T_{cold}, F)$$

  - A decrease over time indicates fouling
  - Actionable information to plan next cleaning activity
  - Send notifications via Event Frames, if threshold is reached.

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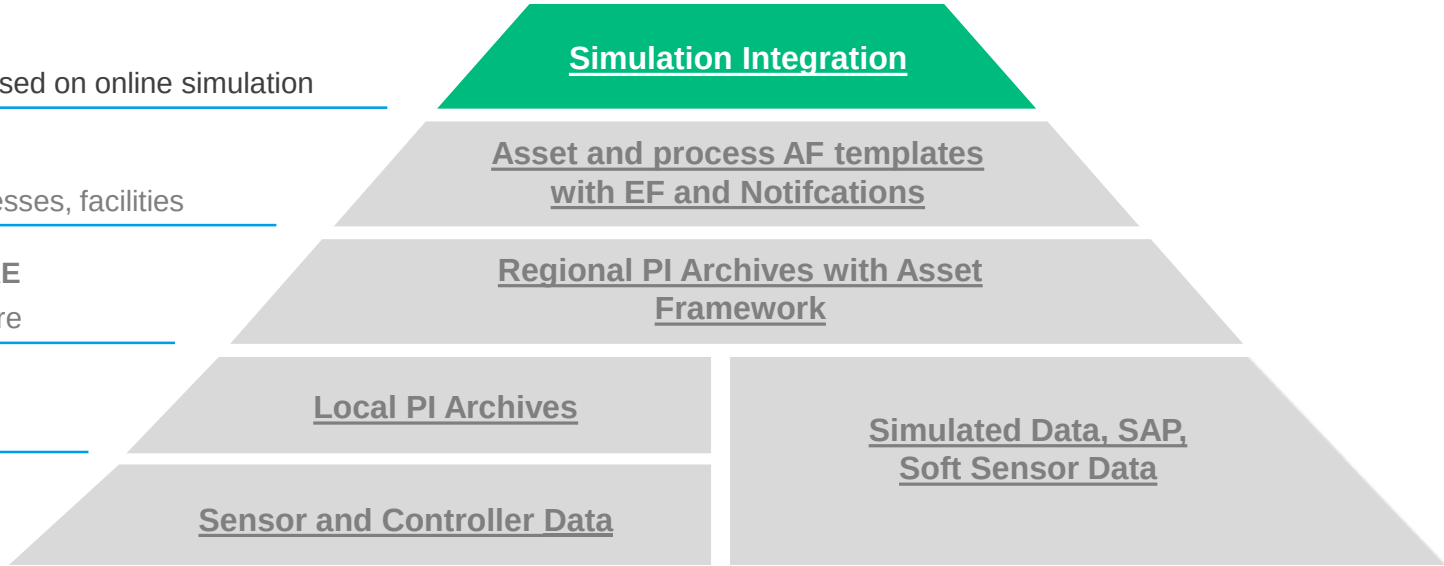
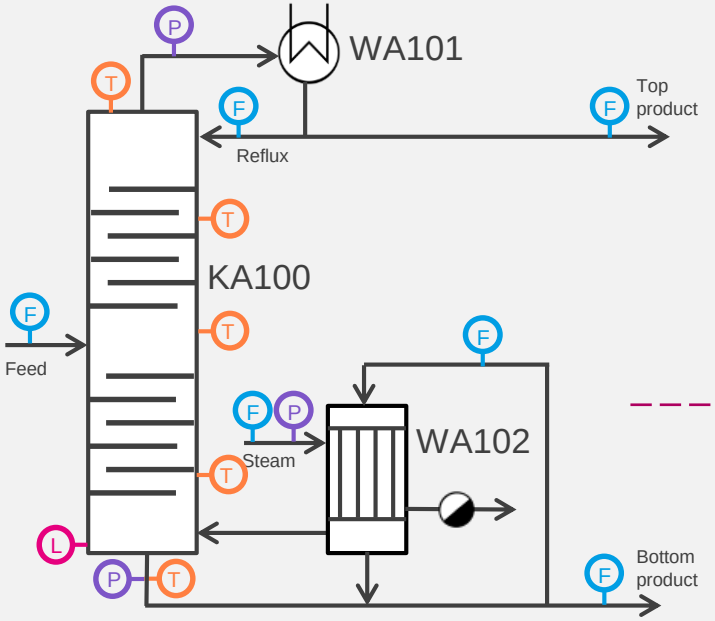
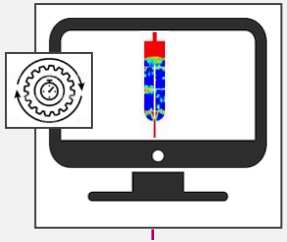


Simulate: Integration of Measured and Simulated Values

✓ Real Plant

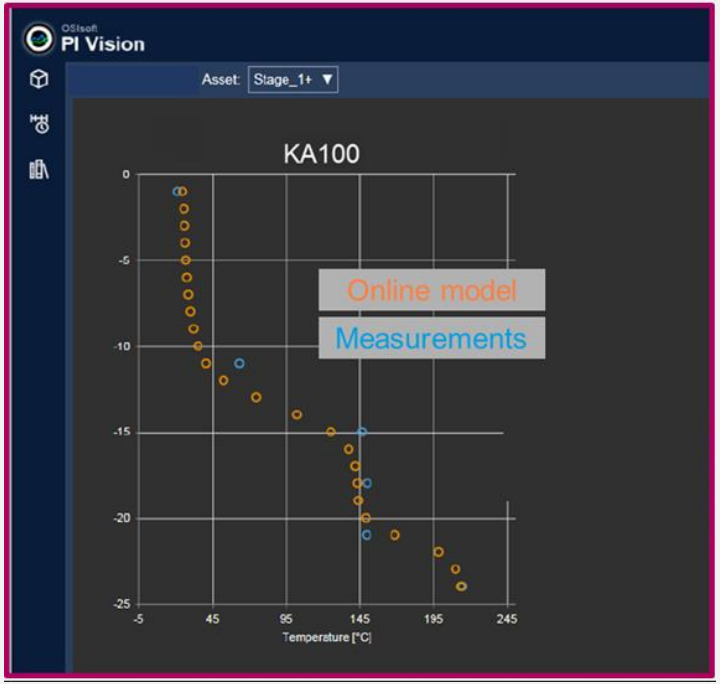


✓ Online Model

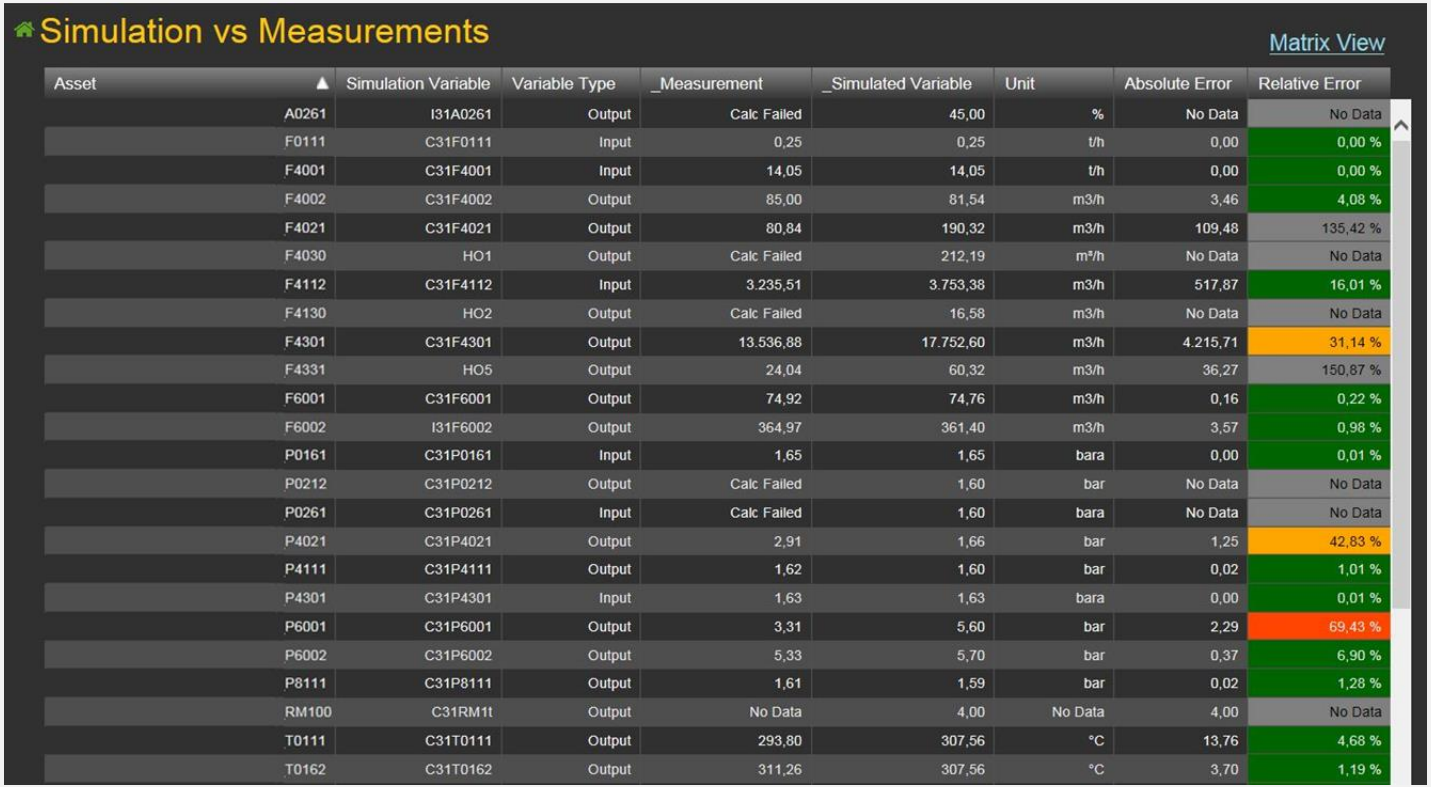


PI Regional
Server with AF

✓ Integration in PI Vision



Simulate: Comparison of Measured and Simulated Values



Simulation vs Measurements

Matrix View

Asset	Simulation Variable	Variable Type	_Measurement	_Simulated Variable	Unit	Absolute Error	Relative Error
A0261	I31A0261	Output	Calc Failed	45,00	%	No Data	No Data
F0111	C31F0111	Input	0,25	0,25	t/h	0,00	0,00 %
F4001	C31F4001	Input	14,05	14,05	t/h	0,00	0,00 %
F4002	C31F4002	Output	85,00	81,54	m3/h	3,46	4,08 %
F4021	C31F4021	Output	80,84	190,32	m3/h	109,48	135,42 %
F4030	HO1	Output	Calc Failed	212,19	m³/h	No Data	No Data
F4112	C31F4112	Input	3.235,51	3.753,38	m3/h	517,87	16,01 %
F4130	HO2	Output	Calc Failed	16,58	m3/h	No Data	No Data
F4301	C31F4301	Output	13.536,88	17.752,60	m3/h	4.215,71	31,14 %
F4331	HO5	Output	24,04	60,32	m3/h	36,27	150,87 %
F6001	C31F6001	Output	74,92	74,76	m3/h	0,16	0,22 %
F6002	I31F6002	Output	364,97	361,40	m3/h	3,57	0,98 %
P0161	C31P0161	Input	1,65	1,65	bara	0,00	0,01 %
P0212	C31P0212	Output	Calc Failed	1,60	bar	No Data	No Data
P0261	C31P0261	Input	Calc Failed	1,60	bara	No Data	No Data
P4021	C31P4021	Output	2,91	1,66	bar	1,25	42,83 %
P4111	C31P4111	Output	1,62	1,60	bar	0,02	1,01 %
P4301	C31P4301	Input	1,63	1,63	bara	0,00	0,01 %
P6001	C31P6001	Output	3,31	5,60	bar	2,29	69,43 %
P6002	C31P6002	Output	5,33	5,70	bar	0,37	6,90 %
P8111	C31P8111	Output	1,61	1,59	bar	0,02	1,28 %
RM100	C31RM1t	Output	No Data	4,00	No Data	4,00	No Data
T0111	C31T0111	Output	293,80	307,56	°C	13,76	4,68 %
T0162	C31T0162	Output	311,26	307,56	°C	3,70	1,19 %

Data Analytics Architecture Implementation

ANALYZE
Root cause analysis, basic forecasts

SIMULATE
Anomaly detection based on online simulation

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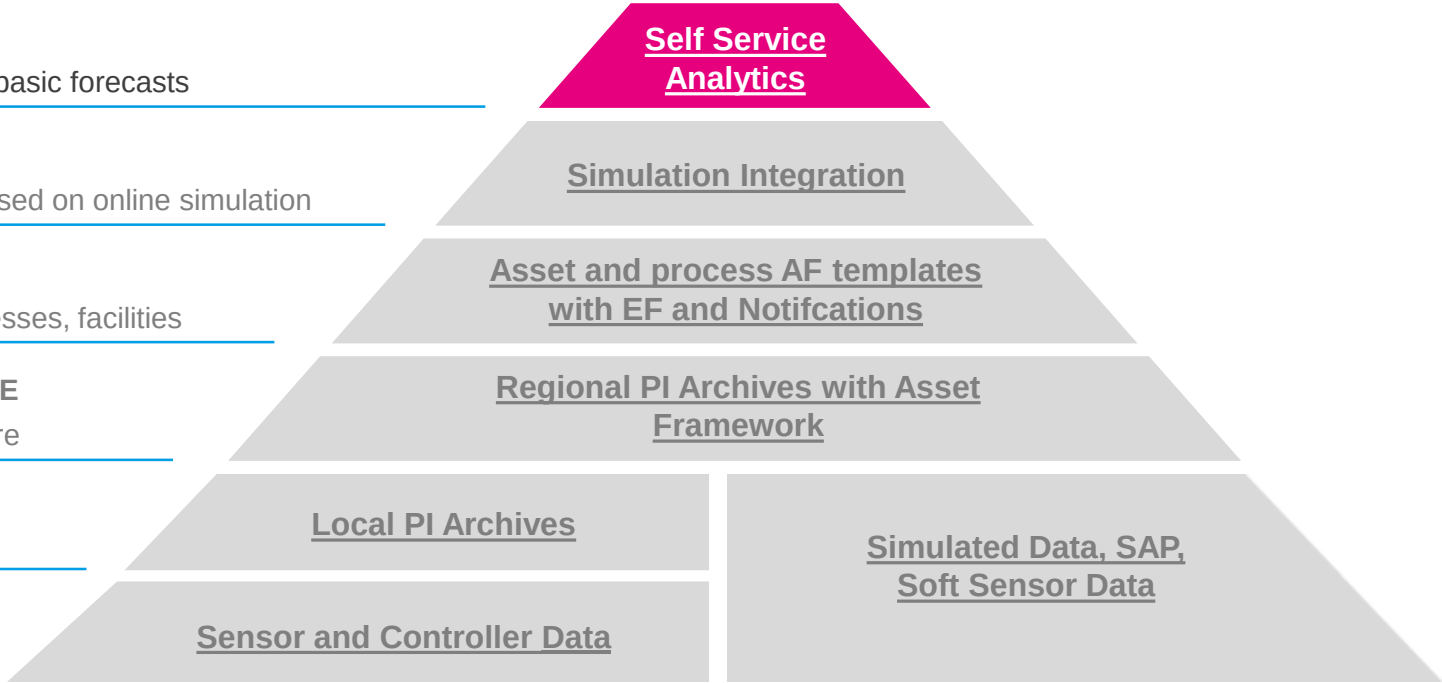


Analyze: Seamless Integration of Self-Service Analytics

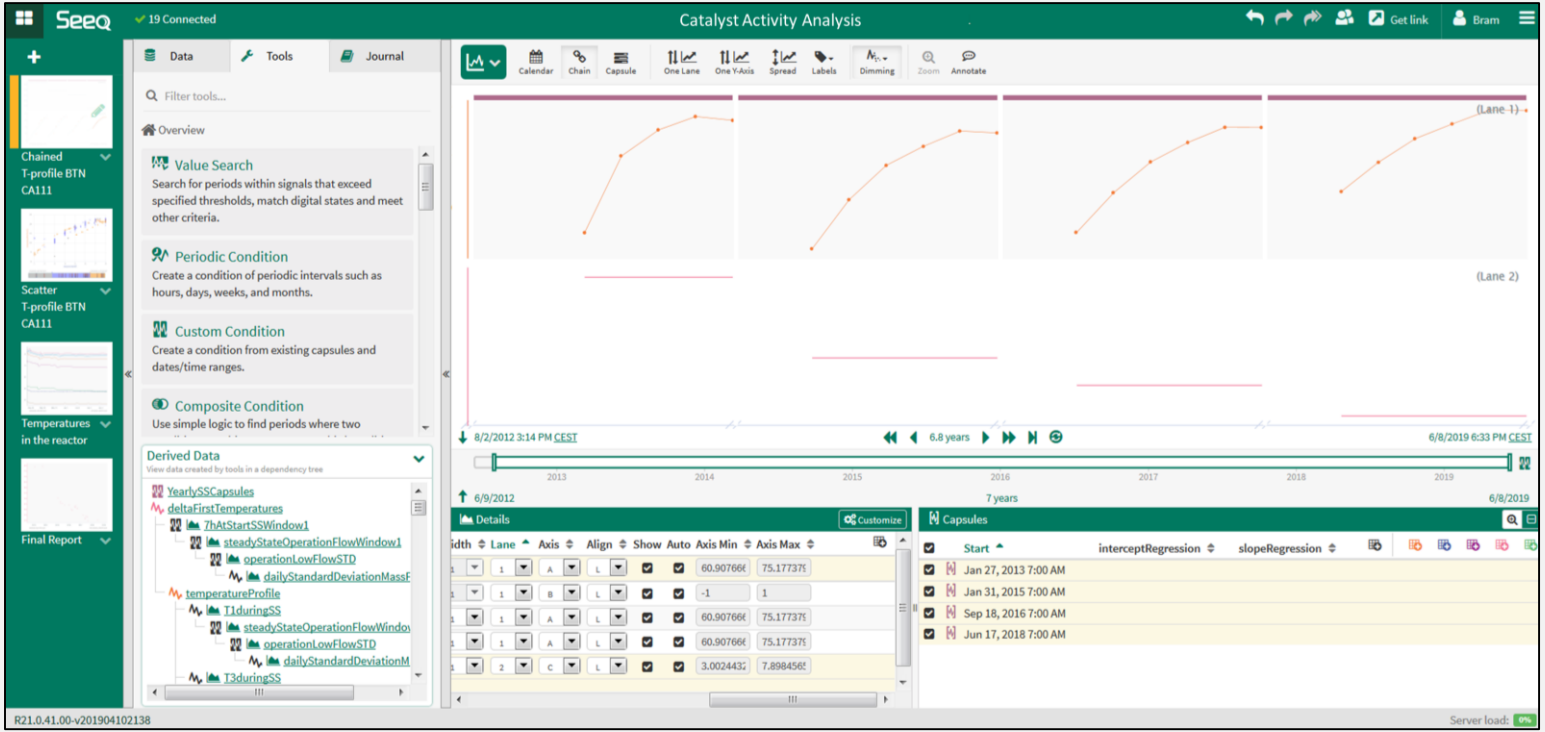
Integration with self-service analytics tools

Analyze: Pattern Recognition

Pattern recognition and notification on flooding in a column

Analyze: Root Cause Analysis

Catalyst activity indicated by T-profile over bed reactor



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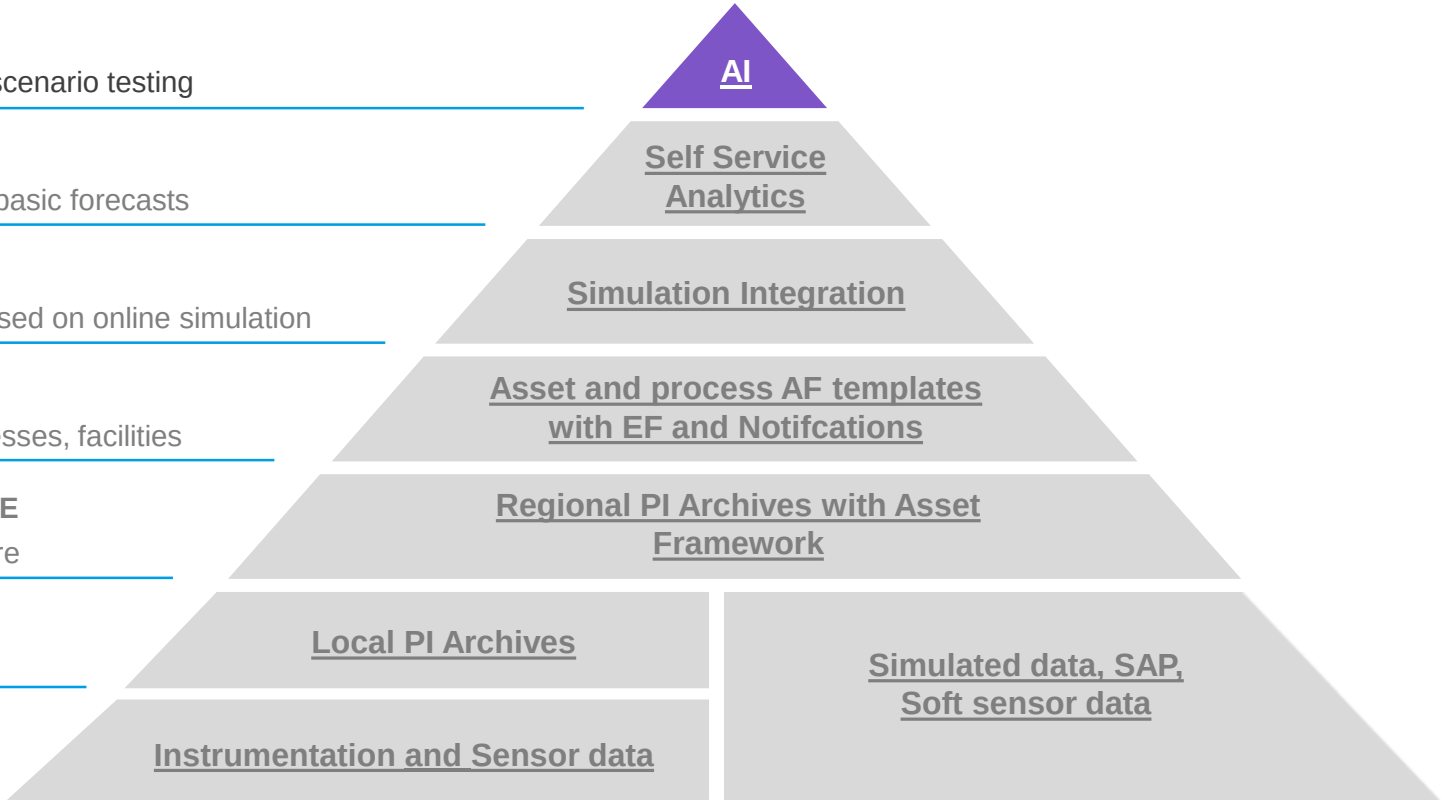


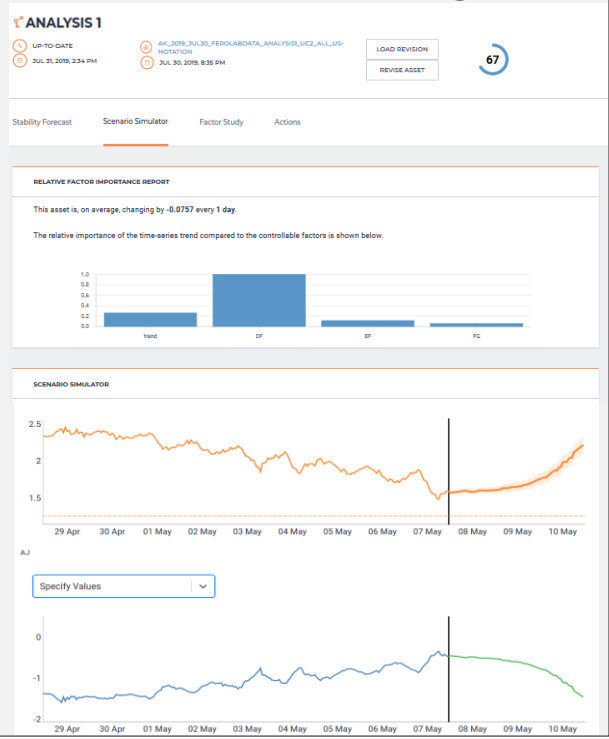
Predict: ML and Advanced Analytics Tools

fēro labs

✓Root cause analysis

✓Multivariate forecasting

✓Scenario testing



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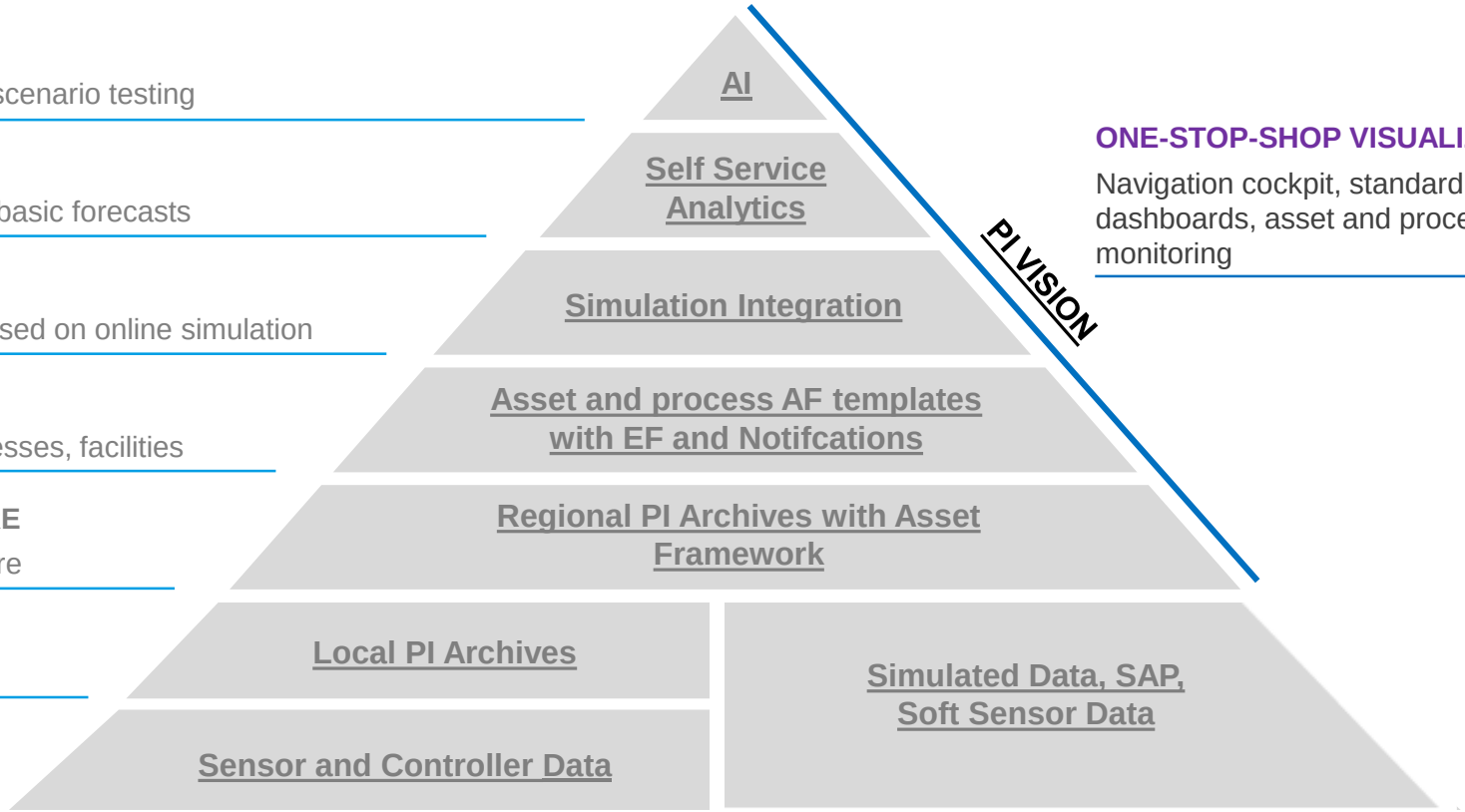
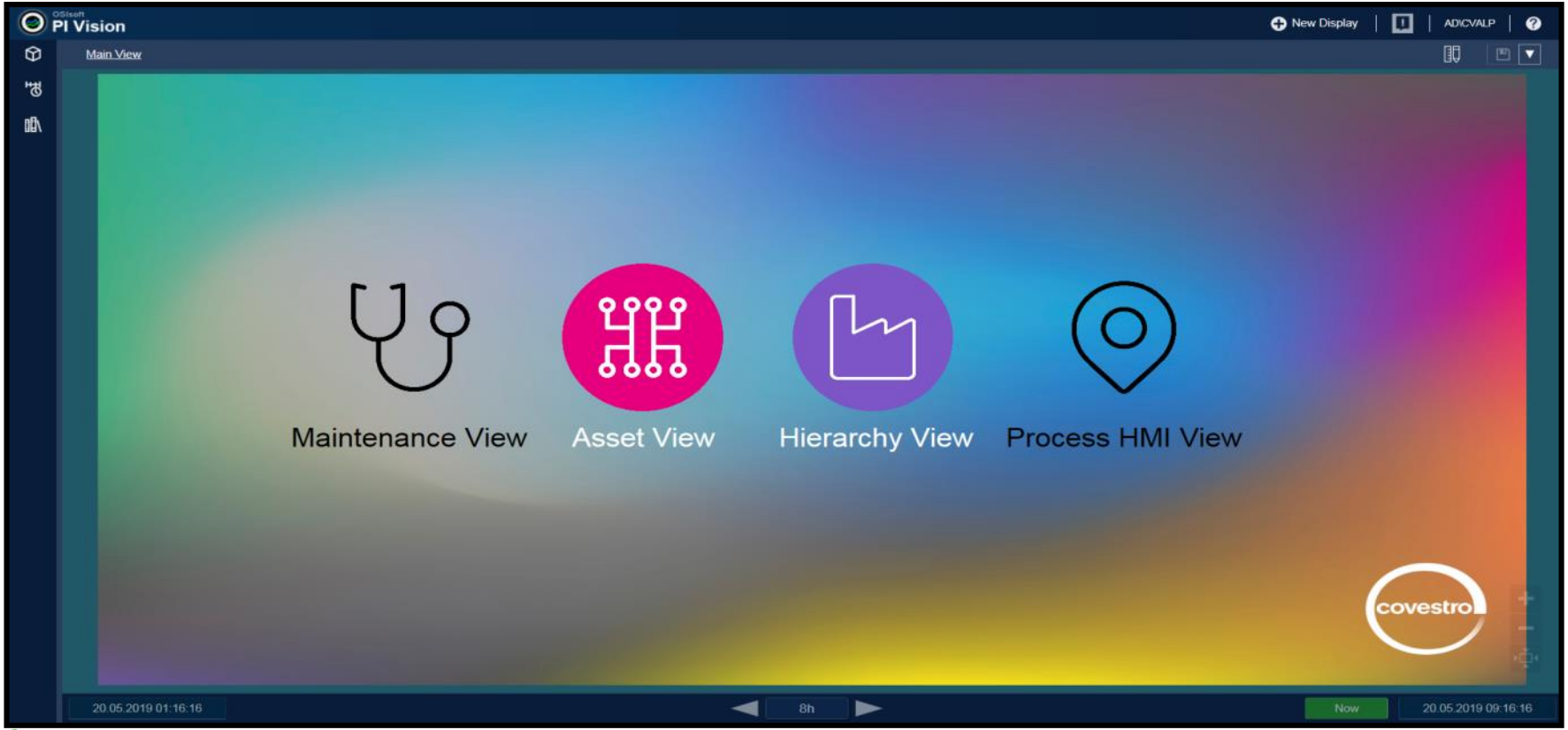


ONE-STOP-SHOP VISUALIZATION
Navigation cockpit, standard dashboards, asset and process monitoring

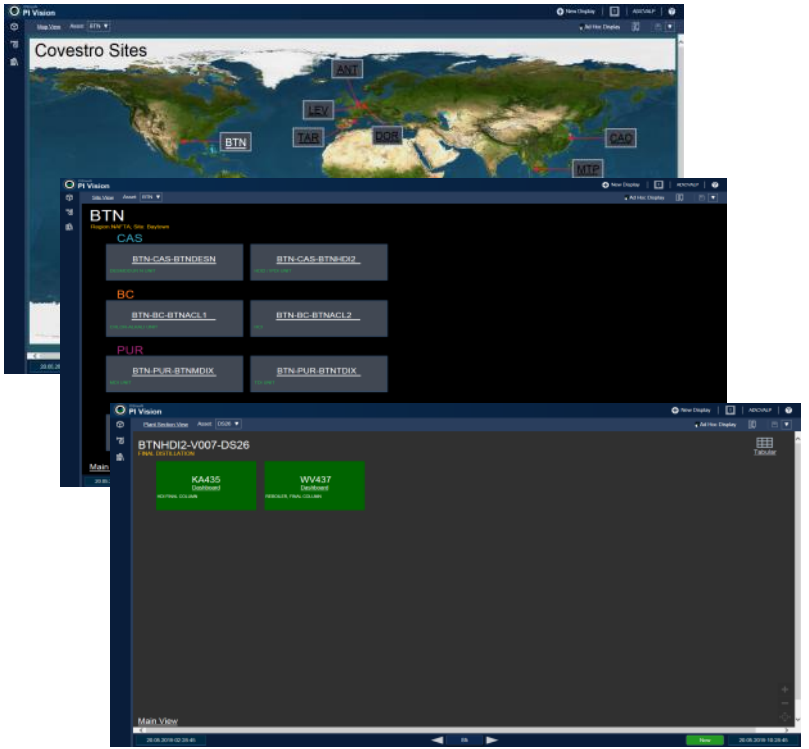
One-Stop-Shop Visualization: Navigation Cockpit



One-Stop-Shop Visualization: Navigation Cockpit

✓ Asset View

✓ Hierarchy View



One-Stop-Shop Visualization: Asset Monitors

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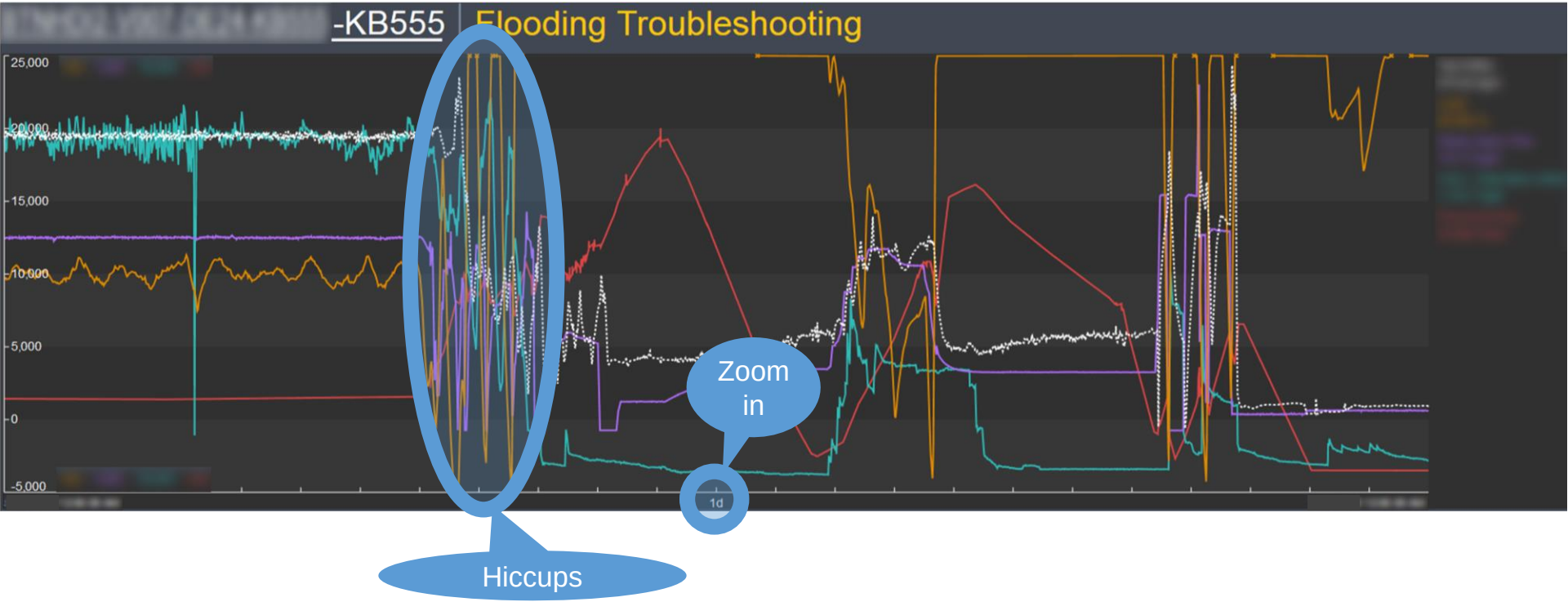

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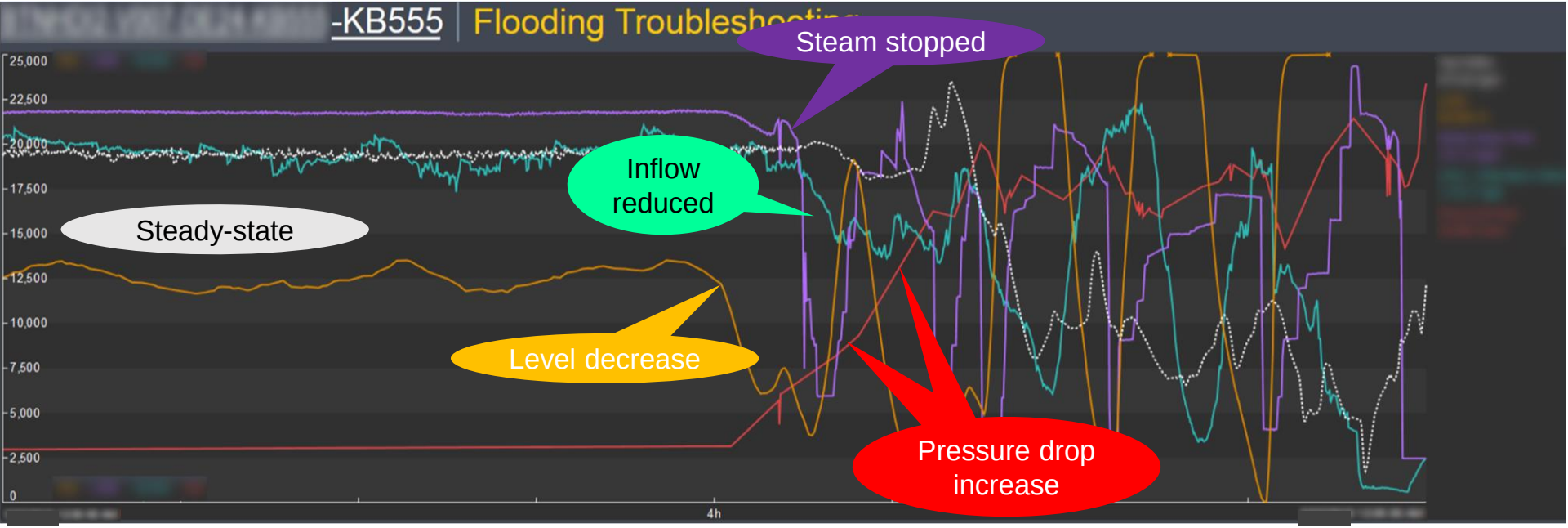

Summary

✓ Challenges

- Difficult access to data
- Island solutions
- Inefficient data visualization

✓ Solution

- Regional AF-based data analytics architecture
- Seamless integration of self-service and AI tools
- One-stop-shop visualization platform

✓ Benefits

- Efficient data access
- Knowledge sharing and collaboration synergies
- Dynamic visualization

> “By exploiting the PI System, we managed to create a scalable data analytics platform that allows our process experts to visualize and analyze process data in a standardized and efficient fashion. Not only have we made it easier for them to turn data into valuable insights, we also have laid a robust basis for continuously harvesting from digital opportunities.”

Jane Arnold, Head of Global Process Control Technology Covestro

Conclusions: Challenges and lessons learned

- **Large number of different assets**
  - Start with the most critical and common assets
- **High variability within asset types**
  - Build general templates depicting the most important asset characteristics
  - Build Vision dashboards that can automatically adapt to different asset configurations
- **Missing instrumentation**
  - Use simulation and soft sensors as possible alternatives
- **Deployment**
  - Use external software to partially automate the deployment process
- **Resistance to digital transformation**
  - Involve stakeholders from the very beginning. Listen to their pain points
  - Show simple but concrete use cases and their added value
  - Continuous dissemination work to bring data analytics possibilities to many users as possible

Questions?

Please wait for the **microphone**

State your **name & company**

Please remember to…

Complete Survey!

Navigate to this session in mobile agenda for survey